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Taylor

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(54) **CONNECTOR FOR SOIL REINFORCING AND METHOD OF MANUFACTURING**

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E02D 29/02 (2006.01)

(52) **U.S. Cl.**
CPC ***E02D 29/0233*** (2013.01); *E02D 2250/00* (2013.01); *E02D 2300/0006* (2013.01); *E02D 2300/0034* (2013.01); *E02D 2600/30* (2013.01)

(58) **Field of Classification Search**
CPC . E02D 29/02; E02D 29/0225; E02D 29/0233; E02D 29/0241
USPC 405/262, 284–286
See application file for complete search history.

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Primary Examiner — Sunil Singh
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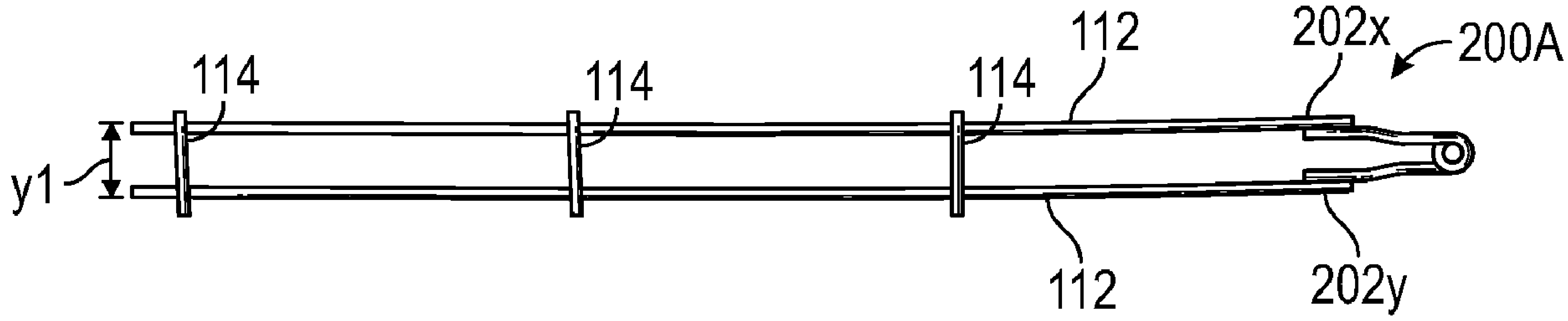
(57) **ABSTRACT**

An apparatus, system and method of connecting an earthen formation to a facing of a mechanically stabilized earth (MSE) structure in which a connector includes a single piece of wire that defines an opening for coupling the connector to an anchor and a pair parallel legs for mechanically connecting the to a soil reinforcing element.

14 Claims, 6 Drawing Sheets



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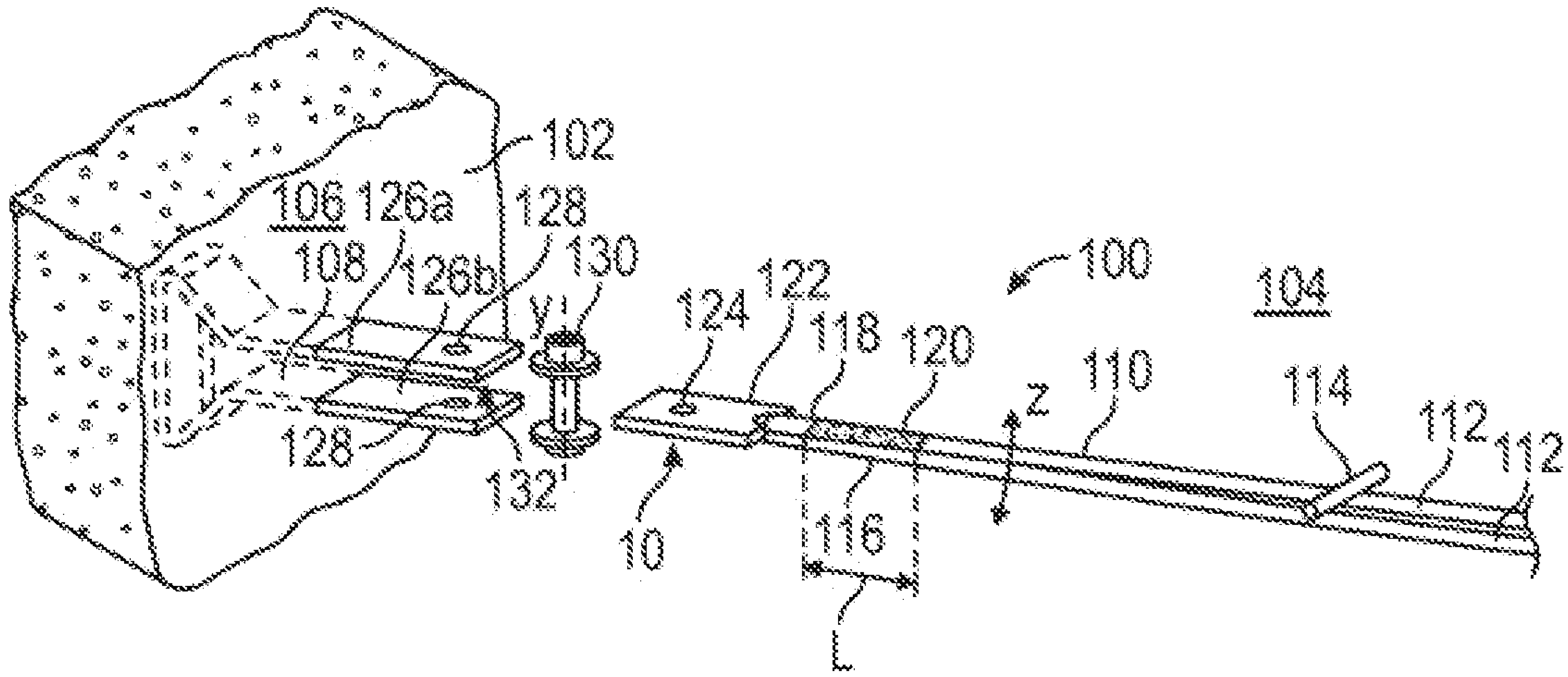

FIG. 1 A
(Prior Art)

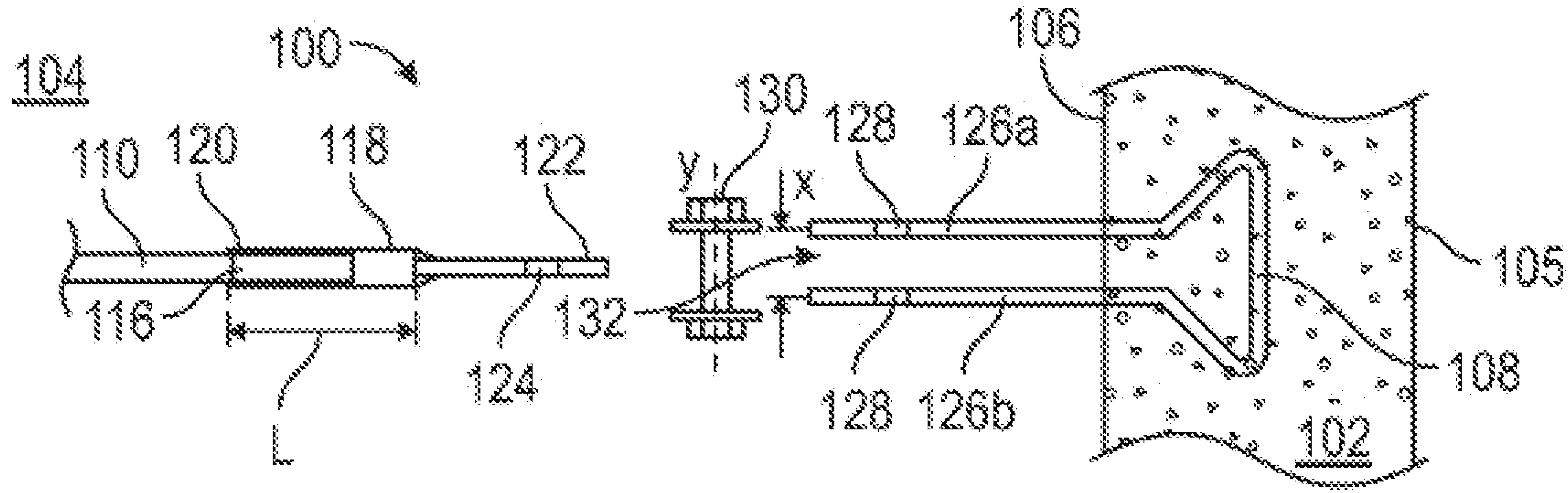

FIG. 1B
(Prior Art)

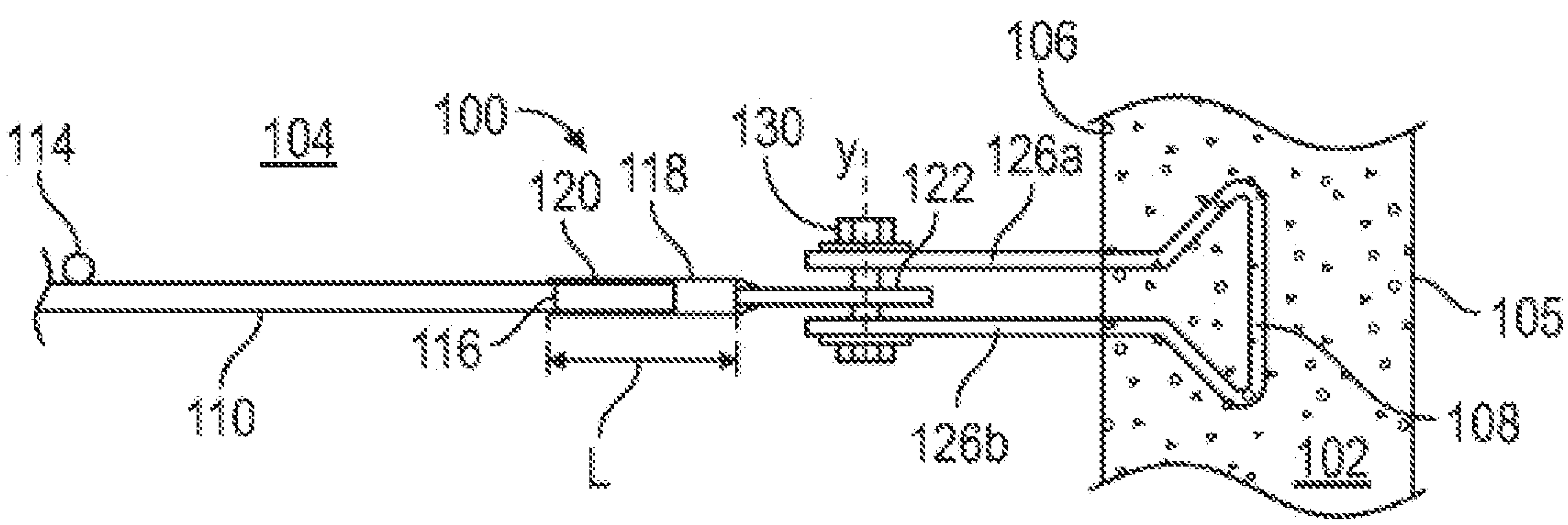

FIG. 1C
(Prior Art)

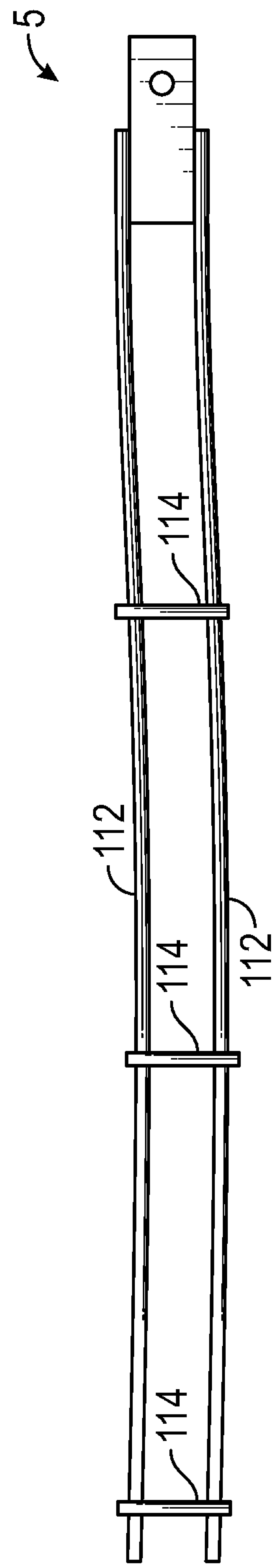

FIG. 2A
(Prior Art)

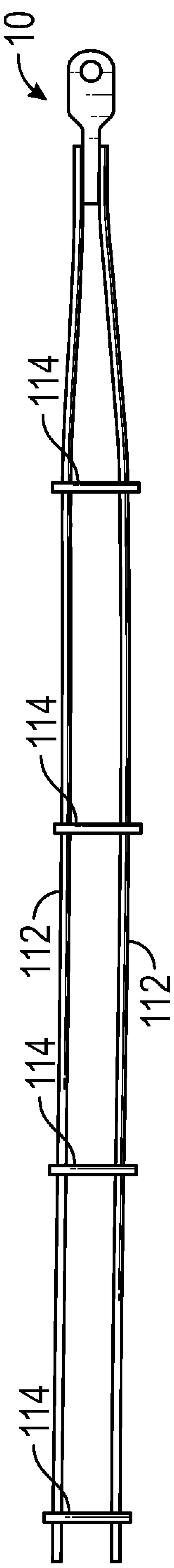

FIG. 2B
(Prior Art)

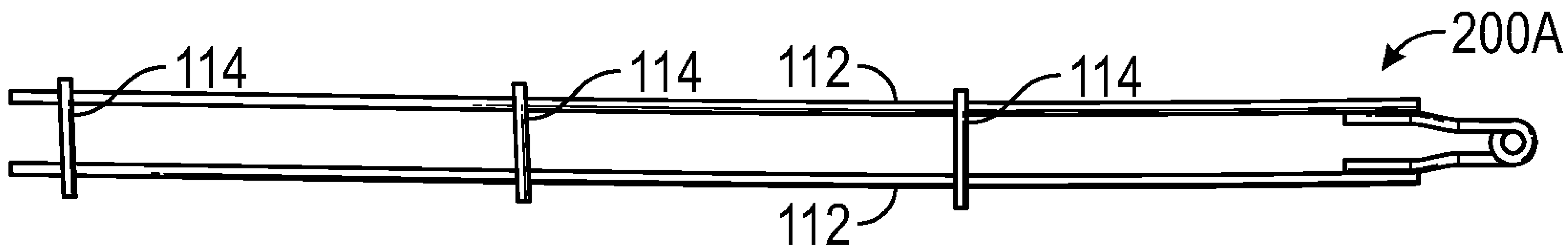

FIG. 3

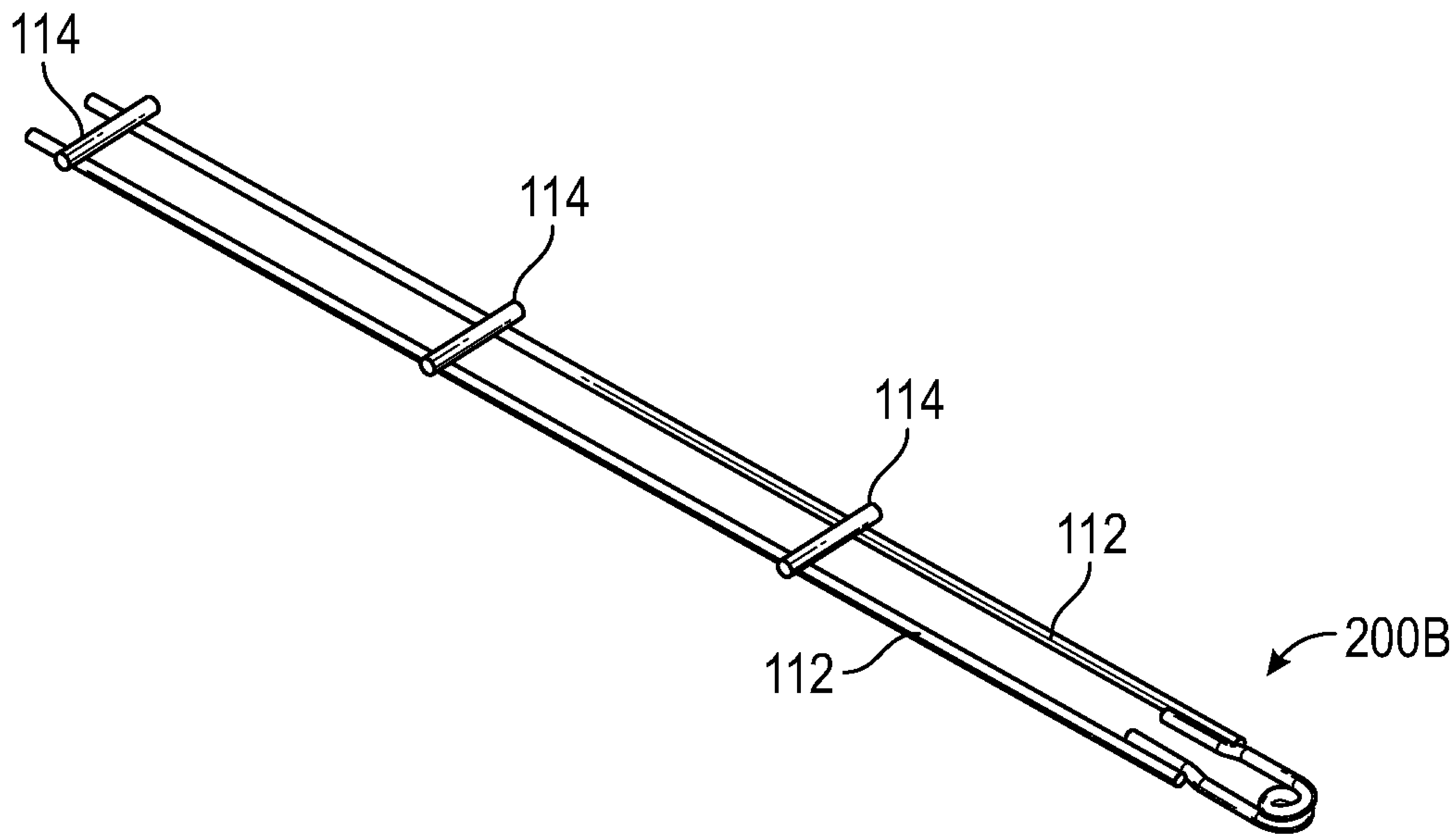

FIG. 4

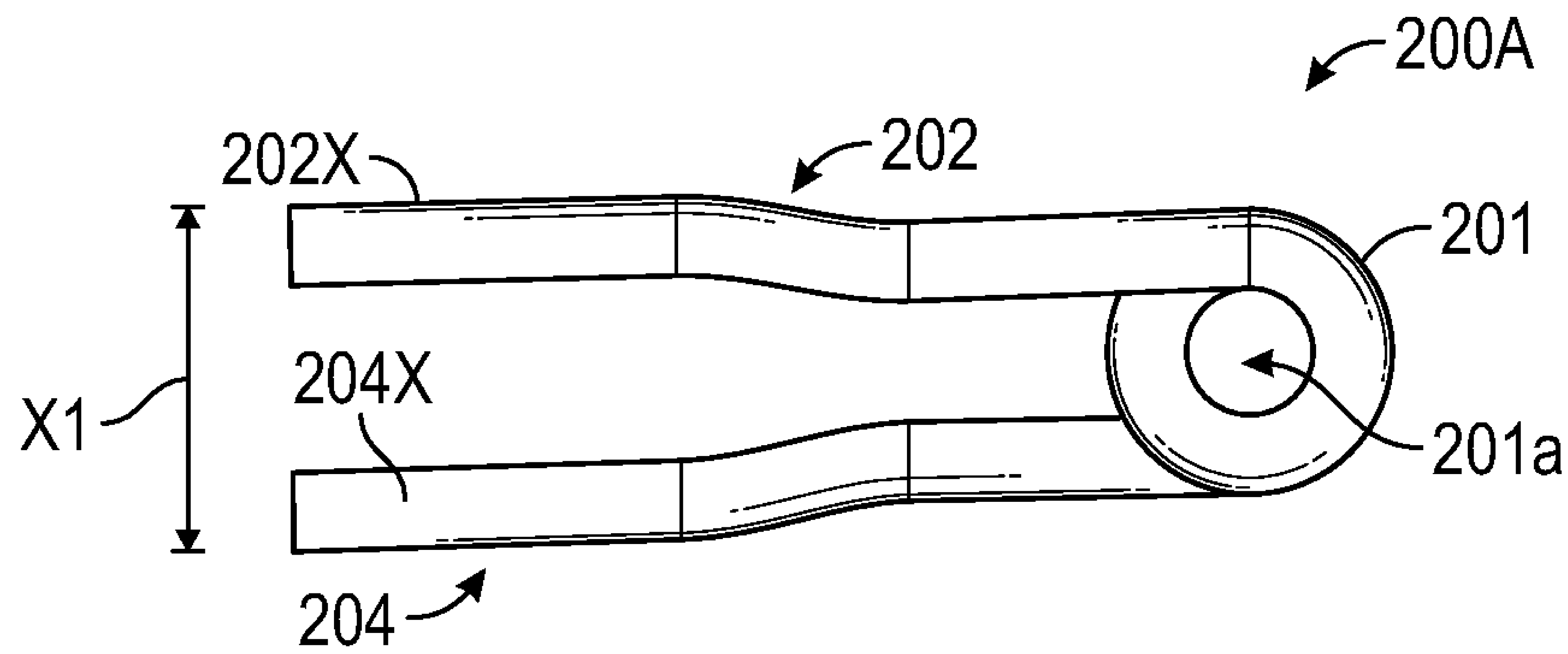

FIG. 5

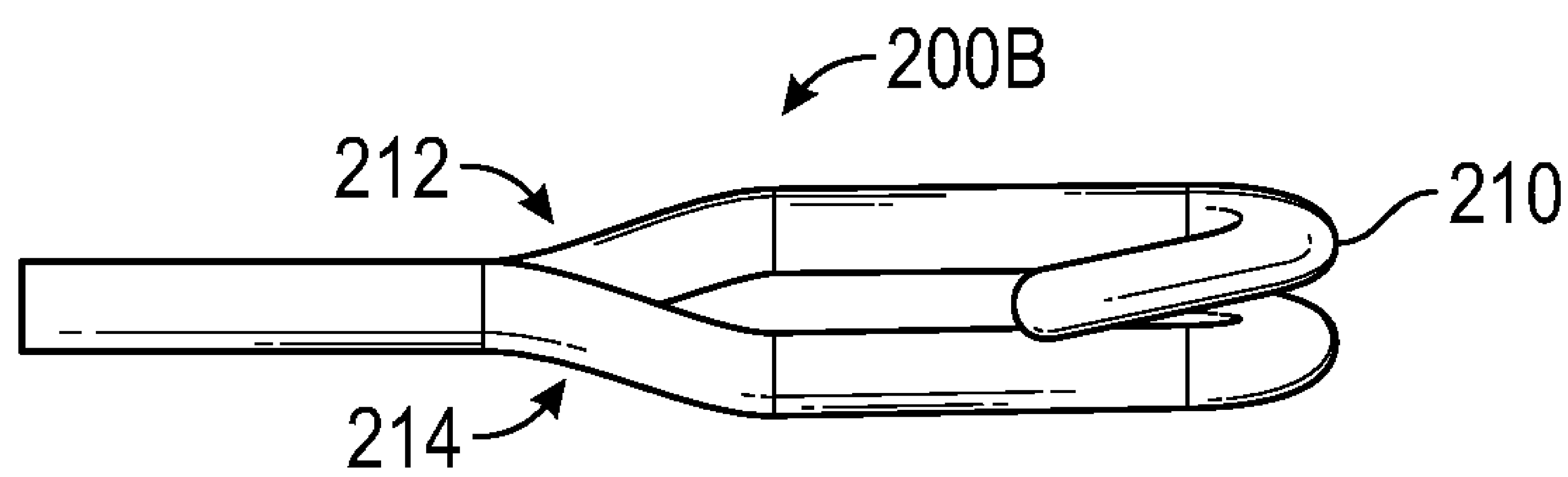

FIG. 6

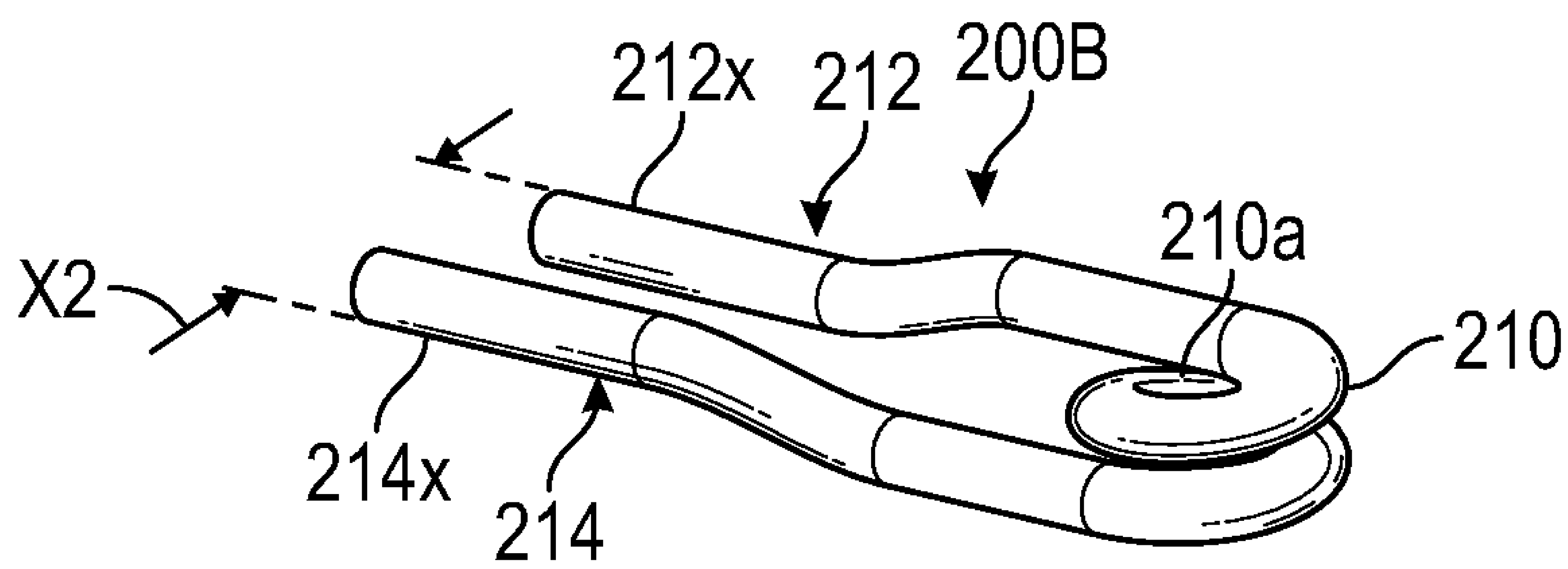

FIG. 7

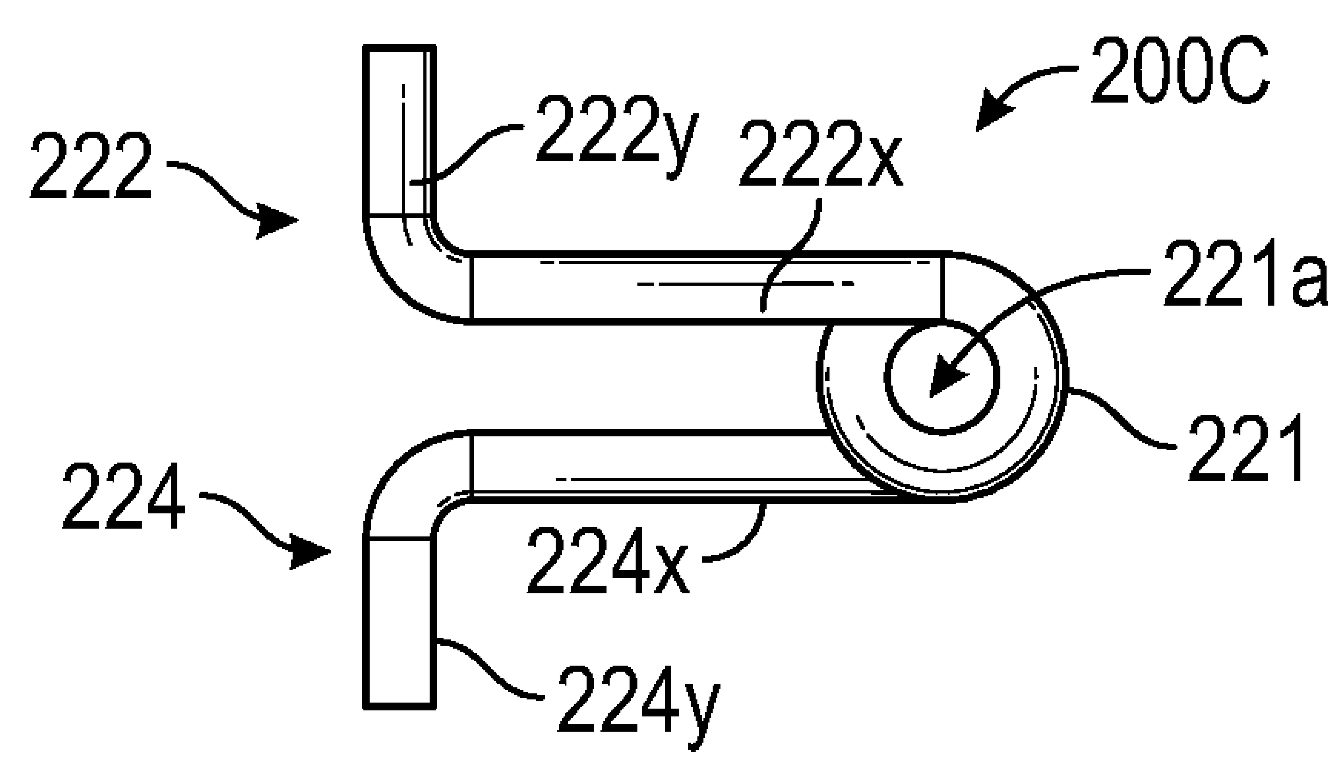

FIG. 8

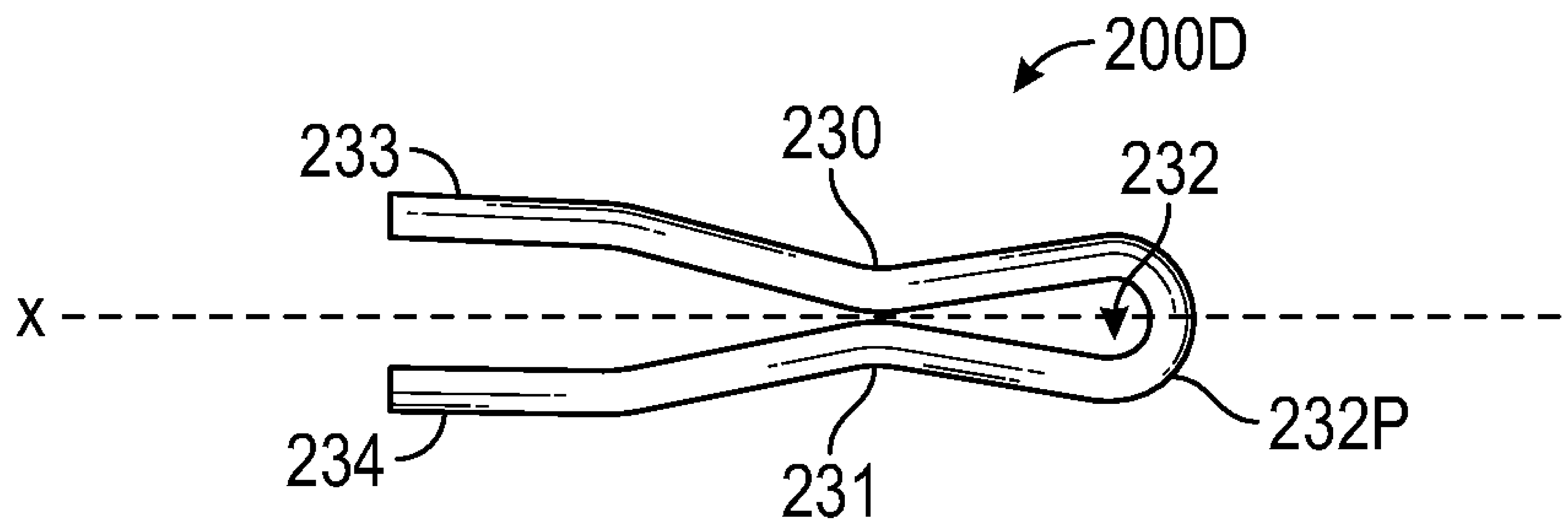

FIG. 9

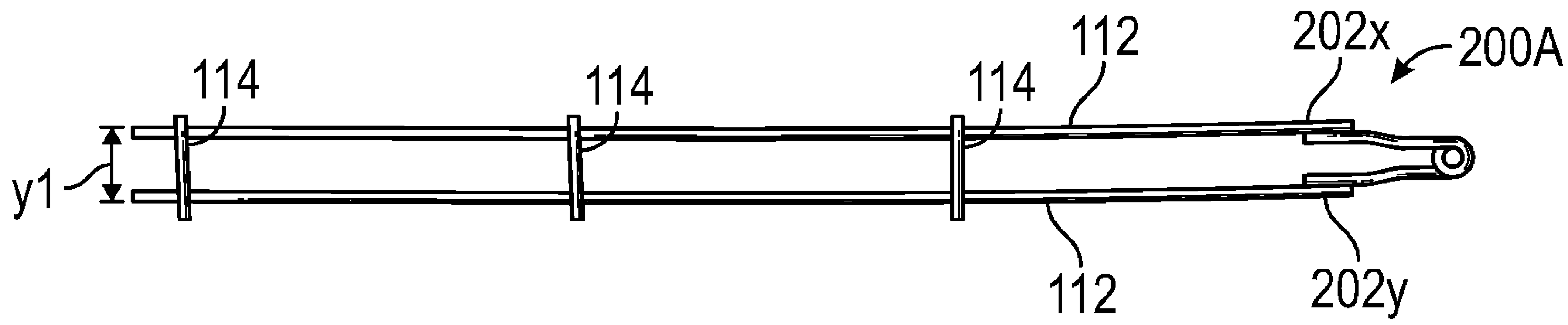

FIG. 10A

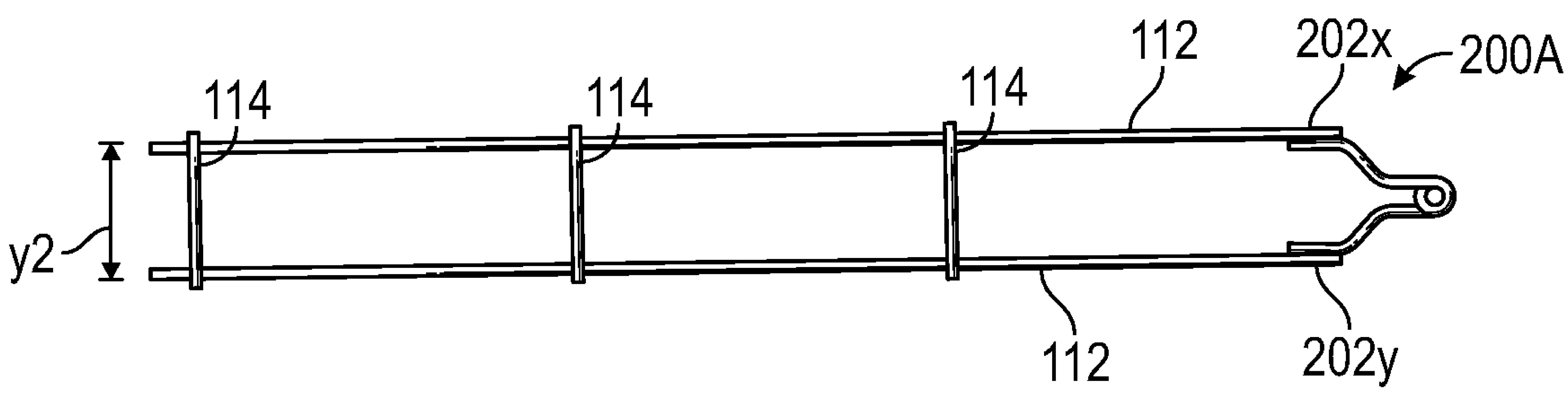

FIG. 10B

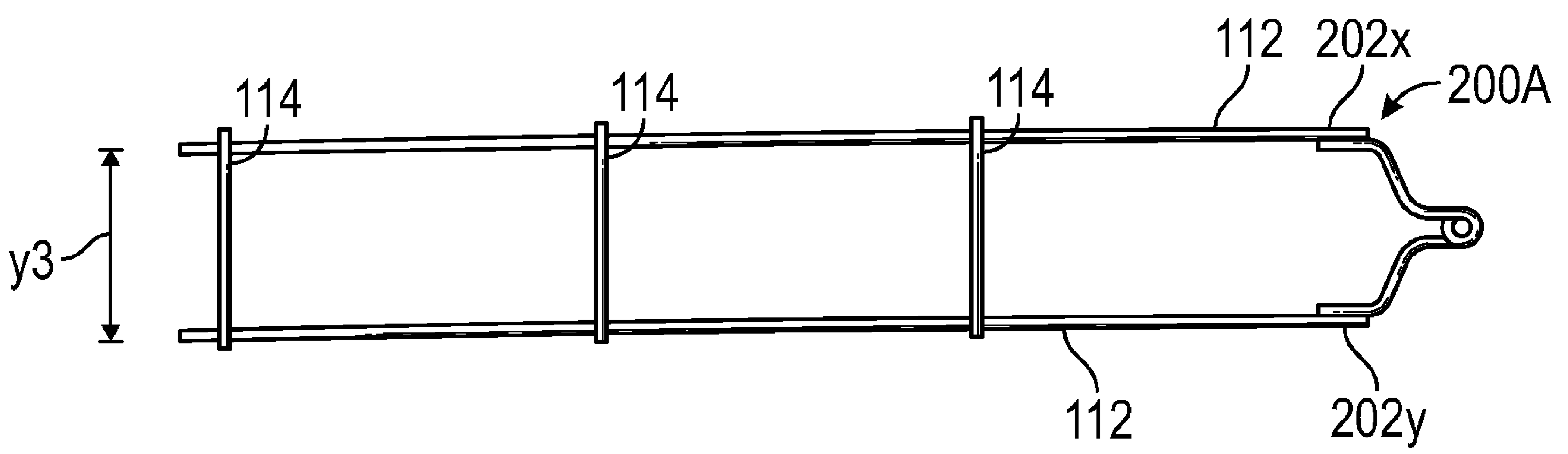

FIG. 10C

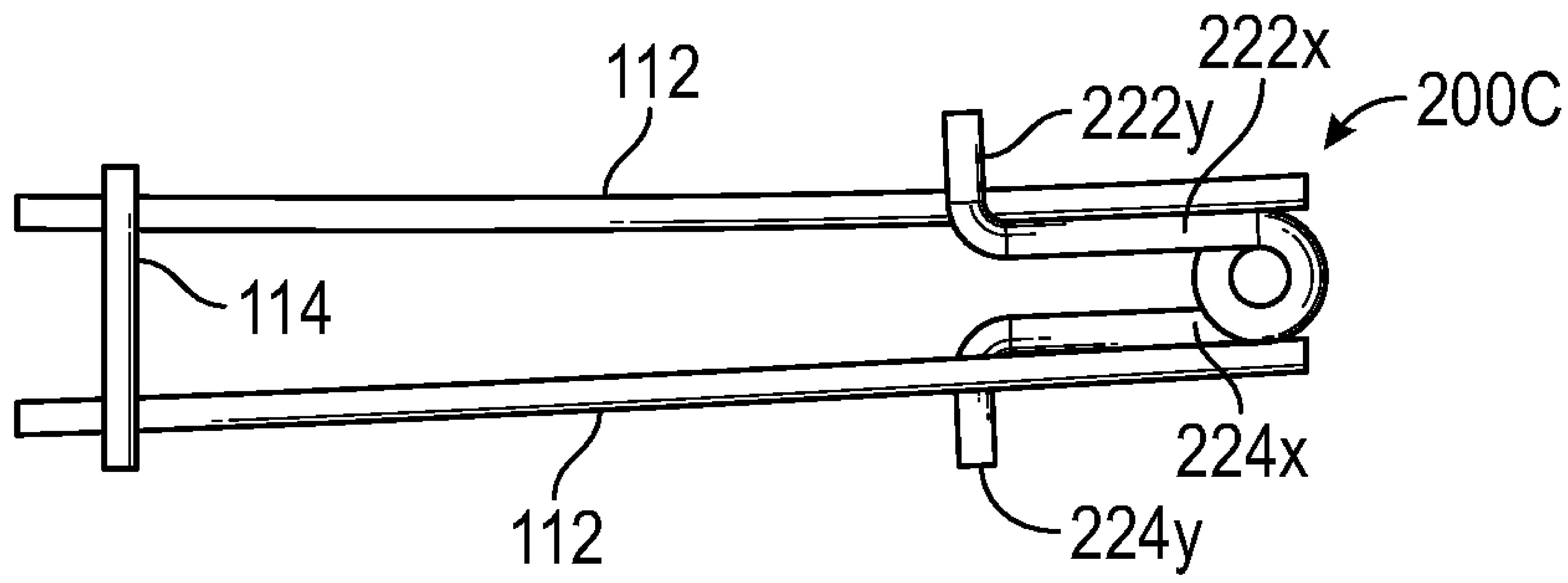

FIG. 11

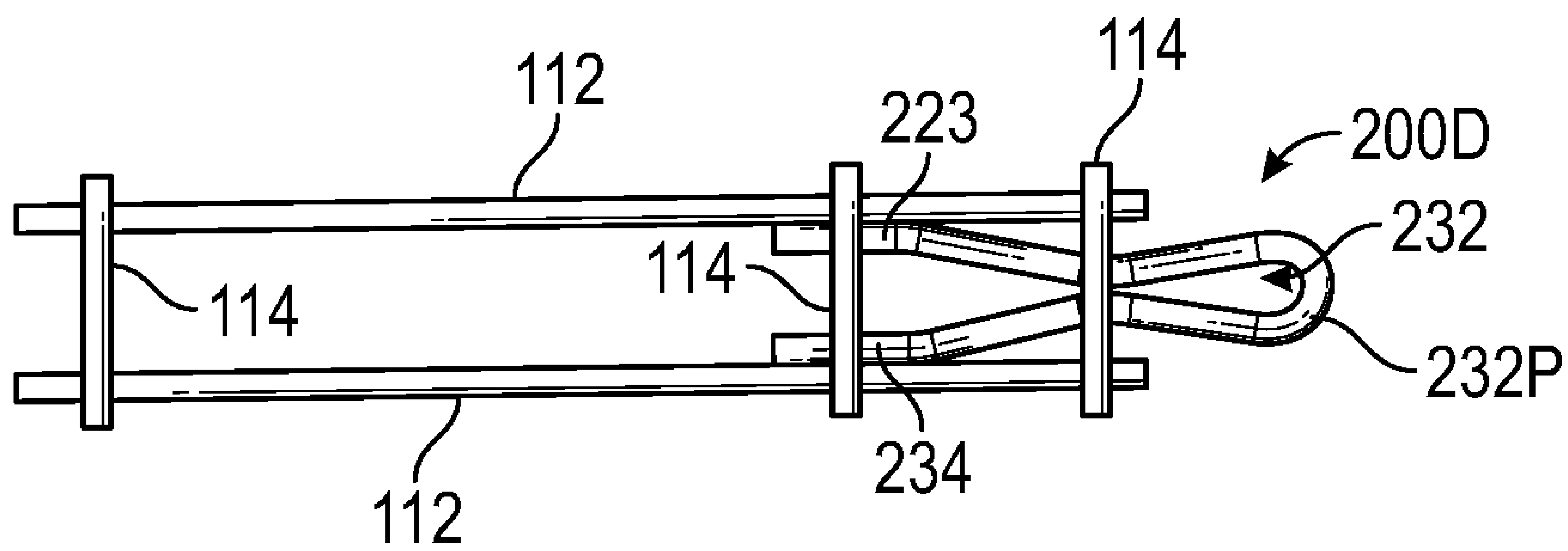

FIG. 12

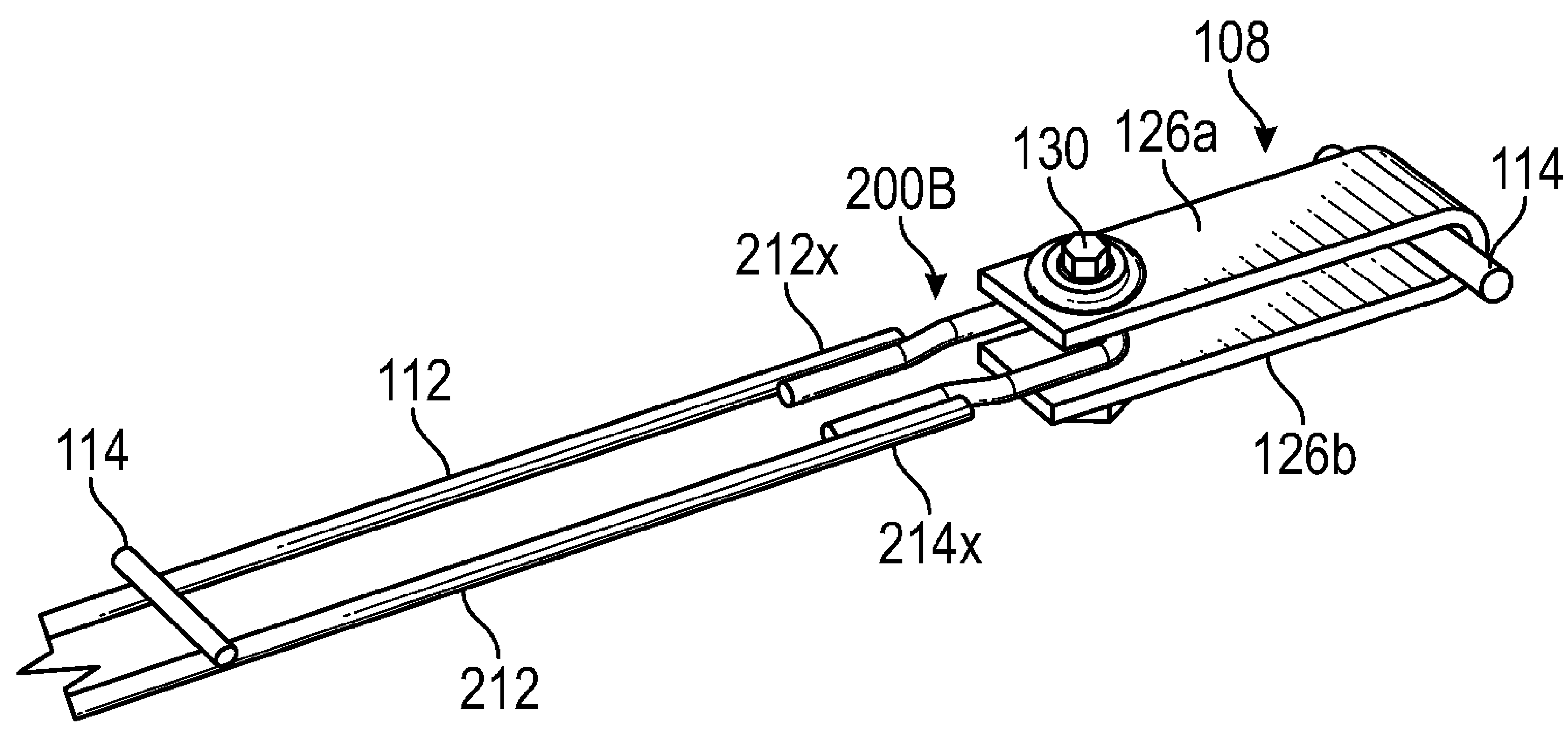

FIG. 13

CONNECTOR FOR SOIL REINFORCING AND METHOD OF MANUFACTURING

CROSS REFERENCE TO RELATED APPLICATIONS

The present application claims priority to and the benefit of U.S. Prov. Pat. App. Ser. No. 63/014,287, which was filed on Apr. 23, 2020, which to the extent that it is consistent with the present disclosure is hereby incorporated herein by reference in its entirety and to the extent that is not inconsistent with the present disclosure.

BACKGROUND

Technical Field

The invention relates to a connector or connection element that is mechanically attached to soil reinforcing that is used in mechanically stabilized earth structures.

Description of the Related Art

Earth retaining structures that are constructed using substantially horizontally positioned soil inclusions in combination with compacted backfill are referred to as mechanically stabilized earth (MSE) structures. MSE structures are known to be used for retaining wall systems, earthen embankments, to support bridge structures as abutments, to retain water in dams, among others.

MSE construction consists of placing compacted backfill and soil reinforcing in at regular thicknesses until a desired height of the structure is reached. The soil reinforcing elements are spaced horizontally and vertically at regular intervals. It is known that the soil reinforcing elements can consist of metal or plastic that may be strips, continuous sheets or grids. The soil reinforcing elements are known to fabricated to form planar and bi-planer elements that contain different surface configurations, patterns, and protrusions along their length. The soil reinforcing elements are generally placed perpendicular to the face of the embankment however may be placed in other directions to bypass obstructions. For noncontinuous soil reinforcing systems the adjacent elements are spaced apart and are in the same plane. The soil reinforcing in combination with the compacted backfill forms a composite structure that behaves similar to reinforced concrete elements. The compacted backfill supports compressive forces and the soil reinforcing supports tensile forces.

In some instances, the soil reinforcing elements are attached to facing element that forms the outer surface of the MSE structure. The facing elements can be vertical or battered and can be formed from concrete, wire, wood, steel, or other like material. The facing prevents erosion of the backfill between successive rows and columns of the soil reinforcing and also serves as a decorative veneer. The proximal ends of the soil reinforcing elements are attached to the facing in many different ways.

A retaining wall soil reinforcing connector and method, is shown and described in U.S. Pat. No. 8,632,277, which shares inventorship with the present application and is commonly owned, is fully incorporated herein by reference.

Referring to FIG. **1A-1C**, an exemplary system **100** for securing a facing **102** to an earthen formation or backfill **104** mass, according to one or more aspects of the disclosure. The facing **102** may include an individual precast concrete panel or, alternatively, a plurality of interlocking precast concrete modules or wall members that are assembled into an interlocking relationship. In another embodiment, the facing **102** may be a uniform, unbroken expanse of concrete or the like which may be poured or assembled into an interlocking relationship. In another embodiment, the facing **102** may be a uniform, unbroken expanse of concrete or the like which may be poured or assembled on site. The facing **102** may generally define an exposed face **105** (FIGS. **1B** and **1C**) and a back face **106**. The exposed face **105** typically includes a decorative architectural facing, while the back face **106** is located adjacent to the backfill **104**. Cast into the facing **102**, or otherwise attached thereto, and protruding generally from the back face **106**, is at least one exemplary anchor **108**. Instead of being cast into the facing **102**, the facing anchor **108** may be mechanically fastened to the back face **106**, for example, using bolts (not shown). As will be described below, several variations of the facing anchor **108** may be implemented without departing from the scope of the disclosure.

The earthen formation or backfill **104** may encompass an MSE structure including a plurality of soil reinforcing elements **110** that extend horizontally into the backfill **104** to add tensile capacity thereto. In an exemplary embodiment, the soil reinforcing elements **110** may serve as tensile resisting elements positioned in the backfill **104** in a substantially horizontal alignment at spaced-apart relationships to one another against the compacted soil. Depending on the application, grid-like steel mats or welded wire mesh may be used as soil reinforcement elements **110**, but it is not uncommon to employ "geogrids" made of plastic or other materials to accomplish the same end.

The earthen formation or backfill **104** may encompass an MSE structure including a plurality of soil reinforcing elements **110** that extend horizontally into the backfill **104** to add tensile capacity thereto. In an exemplary embodiment, the soil reinforcing elements **110** may serve as tensile resisting elements positioned in the backfill **104** in a substantially horizontal alignment at spaced-apart relationships to one another against the compacted soil. Depending on the application, grid-like steel mats or welded wire mesh may be used as soil reinforcement elements **110**, but it is not uncommon to employ "geogrids" made of plastic or other materials to accomplish the same end.

In the illustrated exemplary embodiment, the soil reinforcing element **110** may include a welded wire grid having a pair of longitudinal wires **112** that are substantially parallel to each other. The longitudinal wires **112** may be joined to a plurality of transverse wires **114** in a generally perpendicular fashion by welds at their intersections, thus forming a welded wire gridworks. In exemplary embodiments, the spacing between each longitudinal wire **112** may be about 2 in., while spacing between each transverse wire **114** may be about 6 in. As can be appreciated, however, the spacing and configuration may vary depending on the mixture of tensile force requirements that the reinforcing element **110** must resist.

In one or more embodiments, lead ends **116** of the longitudinal wires **112** may generally converge toward one another and be welded or otherwise attached to a connection stud **118** of a connector **10** that includes a tab or plate **122** extending from the connection stud **118**. The connection stud **118** may include a first end or a stem **120** coupled or otherwise attached to a second end or a tab **122**. As will be described below, several variations of the connection stud **118** may be implemented, without departing from the disclosure. In at least one embodiment, the stem **120** may include a cylindrical body having an axial length L. As illustrated, the lead ends **116** may be coupled or otherwise attached to the stem **120** along at least a portion of the axial length L. In one embodiment, the tab **122** may be a substantially planar plate and define at least one centrally-located perforation or hole **124**.

In at least one embodiment, the facing anchor **108** may include a pair of horizontally-disposed connection points or plates **126** *a*, **126** *b* cast into and extending from the back face **106** of the panel **102**. As can be appreciated, other embodiments include attaching the facing anchor directly to the back face **106**, without departing from the disclosure. Furthermore, as can be appreciated, other embodiments of the disclosure contemplate a facing anchor **108** having a single horizontal plate **126** (not shown), where the tab **122** is coupled only to the single plate **126** via appropriate coupling devices.

Each plate **126** *a, b* may include at least one perforation **128** adapted to align with a corresponding perforation **128** on the opposing plate **126** *a,b*. As illustrated in FIG. **1**B, the plates **126**,*b* may be vertically-offset a distance X, thereby generating a gap **132** configured to receive the tab **122** for connection to the anchor **108**. In operation, the tab **122** may be inserted into the gap **132** until the hole **124** aligns substantially with the perforations **128** of each plate **126** *a, b*. A coupling device, such as a nut and bolt assembly **130** or the like, may then be used to secure the connection stud **118** (and thus the soil reinforcing element **110**) to the facing anchor **108**. In one or more embodiments, the nut and bolt assembly **130** may include a threaded bolt having a nut and washer assembly, but can also include a pin-type connection having an end that prevents it from removal, such as a bent-over portion.

In this arrangement, the soil reinforcing element **110** (as coupled to the connection stud **118**) may be allowed to swivel or rotate about axis Y in a horizontal plane Z (FIG. **1**A). Rotation about axis Y may prove advantageous since it allows the system **100** to be employed in locations where a vertical obstruction, such as a drainage pipe, catch basin, bridge pile, bridge pier, or the like may be encountered in the backfill **104**. To avoid such obstructions, the soil reinforcing element **110** may be pivoted about axis Y to any angle relative to the back face **106**, thereby swiveling to a position where no obstacle exists.

Moreover, the gap **132** defined between two vertically-offset plates **126***a*, **126***b* may also prove significantly advantageous. For example, the gap **132** may compensate or allow for the settling of the MSE structure as the soil reinforcing element **110** settles in the backfill **104**. During settling, the tab **122** may be able to shift or slide vertically about the nut and bolt assembly **130** the distance X, thereby compensating for a potential vertical drop of the soil reinforcing element **110** and preventing any buckling of the concrete facing **102**. As will be appreciated by those skilled in the art, varying designs of anchors **108** may be used that increase or decrease the distance X to compensate for potential settling or other MSE mechanical phenomena.

Furthermore, it is not uncommon for concrete facings **102** to shift in reaction to MSE settling or thermal expansion/contraction. In instances where such movement occurs, the soil reinforcing elements **110**, which include longitudinal wires **112**, of the disclosure are capable of correspondingly swiveling about axis Y and shifting the vertical distance X to prevent misalignment, buckling, or damage to the concrete facing **102**.

As described above, the connector **10**, which couples the reinforming element **110** (e.g., wires) to the anchor **108**, includes the stem **120** that is coupled to a tab **122** that includes a hole **124** for receiving a fastener (e.g., the bolt of the nut and bolt assembly **130**) therethrough and through perforations **128** defined in vertically-offset plates **126***a*, **126***b* of the anchor **108**. Various other kinds of connectors are illustrated in FIGS. **2**A-**2**D. For example, as shown in FIG. **2**A, a connector **5** may be a plate, which may have a rectangular configuration, that is welded (e.g., resistive welded) to the longitudinal wires **112**. A hole is formed within the plate of the connector **5** to receive a fastener (not shown) therethrough. FIG. **2**B, illustrates another connector **10**, which includes a stem that is welded to the longitudinal wires **112** and tab through which a hole is formed to receive a fastener, similar to the connector that is described above with respect to FIGS. **1**A-**1**C.

It should be understood that the background is provided to aid in an understanding of the present disclosure and that nothing in the background section shall be construed as an admission of prior art in relation to the inventions described herein.

SUMMARY

In an embodiment, a connection element for a mechanically stabilized earth structure may include a first longitudinal wire that includes a proximal end and a second longitudinal wire that includes a proximal end. The connection element may include a pair of legs that are biased apart from one another, each of the pair of legs configured to be coupled to respective ones of the proximal end of the first longitudinal wire and the proximal end of the second longitudinal wire, the pair of legs being biased apart from one another; and a fastener receptacle. The connection element may have a unitary construction and may be formed from a single length of wire. The single length of wire may have a round, square, rectangular, hexagonal, or octagonal cross-section, or any combination thereof, but is not limited thereto. The pair of legs may include a first leg and a second leg, the first leg including a first elongated longitudinally extending section, the second leg including a second elongated longitudinally extending section, the first elongated longitudinally extending section being parallel to the second elongated longitudinally extending section. The first leg may include a first section extending longitudinally to a distal end and a second section that orthogonally extends from the distal end of the first section; and the second leg may include a first section extending longitudinally to a distal end and a second section that orthogonally extends from the distal end of the second section. The single length of wire may be bent a number of degrees about an axis extending orthogonally relative to a lengthwise axis of the single piece of wire to form a coiled section that defines the fastener receptacle. The number of degrees may equal 180 degrees, 270 degrees, or 540 degrees, but may also have a greater or lesser number degrees corresponding to, for example, complete or half revolutions relative to the axis about which the wire is bent.

In another embodiment, a system for securing a facing of an earthen formation may include the above-described connection element and may also include a facing anchor. The facing anchor may be hingedly connected to the connection element via a fastener extending through the fastener receptacle of the connection element.

In yet another embodiment, a method of manufacturing a soil reinforcing connection element assembly may include: bending a connection element consisting of a single wire into a configuration with a central opening and two legs at the distal ends that are substantially parallel; providing a soil reinforcing element with a proximal end and a terminal end

consisting of at least two longitudinal members and cross members; and/or mechanically joining the connection element distal ends to the proximal ends of the soil reinforcing element.

These and other aspects of the present disclosure are described in greater detail below with reference to the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is an exploded perspective view of a prior art soil reinforcing system.

FIG. **1**B is a side view of the system shown in FIG. **1**A.

FIG. **1**C is a side view of the system shown in FIG. **1**A coupled together.

FIG. **2**A is a plan view of a proximal end connector plate shown coupled to longitudinally extending soil reinforcing wires according to the prior art.

FIG. **2**B is a plan view of a proximal end connector plate shown coupled to longitudinally extending soil reinforcing wires according to the prior art.

FIG. **3** is a plan view of an embodiment of a single wire connector shown coupled to longitudinally extending soil reinforcing wires according to the present disclosure.

FIG. **4** is a perspective view of another embodiment of a single wire connector shown coupled to longitudinally extending soil reinforcing wires according to the present disclosure.

FIG. **5** is a plan view of a further embodiment of a single wire connector of FIG. **3**.

FIG. **6** is a side view of a still further embodiment of a single wire connector according to the present disclosure.

FIG. **7** is a perspective view of the single wire connector of FIG. **6**.

FIG. **8** is a plan view of the single wire connector of FIG. **6**.

FIG. **9** is a plan view of another embodiment of a single wire connector.

FIGS. **10**A-**10**C depict the single wire connector of FIG. **3** having legs spaced apart by different widths from one another and coupled to longitudinally extending soil reinforcing wires.

FIG. **11** is a plan view of the connector of FIG. **8** shown coupled to longitudinally extending soil reinforcing wires.

FIG. **12** is a plan view of the connector of FIG. **9** shown coupled to longitudinally extending soil reinforcing wires.

FIG. **13** Is a perspective view of the single wire connector of FIG. **4** shown coupled to longitudinally extending soil reinforcing wires and coupled to a connection place.

DETAILED DESCRIPTION

Various embodiments and aspects of the present disclosure will be described with reference to the accompanying drawings in which like or similar features are labeled with the same reference number. The following description and drawings are illustrative of the present disclosure and are not to be construed as limiting the disclosure. Numerous specific details are described to provide a thorough understanding of various embodiments of the present disclosure. However, well-known or conventional details are not described in order to provide a concise discussion of embodiments of the present disclosure.

The present disclosure presents a connector that is advantageous over such prior art connectors as are described above for a variety of reasons including more efficient use of material and time as a unitary length of wire may be configured in a greater variety of sizes and can be coupled to the MSE faster and more cheaply. For example, in FIG. **2**B, the connector **10** includes a stem that is narrower than the spacing between longitudinal wires **112** such that welding the longitudinal wires **112** to the stem of the connector **10** would require compressing the longitudinal wires **112** toward one another and in contact with the stem of the connector **10**, which would increase the time required for installation. In contrast, the connector **5** has a rectangular shape and may be pre-formed to correspond to the spacing of the longitudinal wires **112**. The connector **5** would necessarily require more material than the connector **10**, and for both of the connectors **5**, **10**, a hole would have to be drilled through the material for a receptacle for securing the connectors **5**, **10** to an anchor. The connectors known in the art that utilize a plate, e.g., connector **5**, are known to be attached to soil reinforcing elements with longitudinal wires that are spaced at two inches. The narrow plate controls the cost of the system it is therefore advantageous to have as narrow as plate as possible. Most welding fabrication machines are not constructed to weld a narrow element, such as the two-inch element. Because of this the number of fabricators diminishes and the need for a specialized welded wire machines increase.

The present disclosure provides a connector that is advantageous over the connectors **5**, **10** in that it uses material efficiently and can be configured in a variety of sizes such that there is a greater number of options for spacing between the longitudinal wires **112**. For example, it may be preferable to have a relatively narrow spacing between the wires such that the MSE structure is relatively rigid. The present disclosure provides for a greater variety of configurations of the connector while using materials efficiently and not necessitating any change in the manufacturing process. Conventionally, the connectors **5**, **10**, in contrast may only be readily available in certain sizes as it would be inefficient for a factory to make a great variety of connectors having different sizes.

The present disclosure provides various embodiments of a one-piece MSE connector that facilitate soil reinforcing with a variety of longitudinal wire spacings to be connected to a variant of the connector without an increase in the component cost. Another advantage of the connector is that it is a single point connector that allows soil reinforcing to swivel in order to avoid vertically-disposed obstructions, such as drainage pipes, catch basins, bridge piles, or bridge piers, which may be encountered in the adjacent compacted backfill. Still another advantage of the connector is it can be attached to varying width soil reinforcing elements providing a distinct advantage that allows the system to be attached to welded wire fabricated on almost any automated mesh welder by most welded wire suppliers.

In accordance with an embodiment of the present disclosure, a connector **200**A that may be used instead of the connectors **5**, **10** (FIGS. **1**-**2**B) is now described with reference to FIGS. **3**-**5**.

The connector **200**A may have a unitary construction and may be formed from a single length of wire. As used herein, the term “unitary” means formed of a single piece, e.g., a single length of wire. The wire may be formed of a material including a metal material, such as, stainless steel or other metals or metal alloys. The cross section of the wire for the connector can be round, square, rectangular, hexagonal, octagonal, or a combination thereof. The modification of the terminal end profile allows for an increase in area to apply different types of mechanical attachment processes such as metal added welding, or resistance welding.

The connector **200**A may include a first leg **202** and a second leg **204**. Distal sections **202***x*, **204***x* of respective ones of the first and second legs **202**, **204** may be substantially parallel to one another and may be spaced apart by a distance X**1** at the distal end D of the connector **200**A, which may be greater than the width of the connector **200**A at the proximal end P. The connector **200**A may include a receptacle **201**, at a proximal section of the connector **200**A. The receptacle **201** may define an opening **201***a* through which a fastener, e.g., a bolt, may be received to secure the connector **200**A to an anchor (e.g., anchor **108**). The first and second legs **202**, **204** may be secured to respective longitudinal wires **112**, e.g., via resistive welding, which is advantageous such that there is no added metal in forming the weld.

As shown in FIGS. **6**-**7**, a connector **200**B is substantially similar except that the distal end defines a narrower width or space X**2** between leg sections **212***x*, **214***x* of the first and second legs **212**, **214** relative to its proximal end. The connector **200**B is similarly formed in other respects and also includes a receptacle **210** defining an opening **210***a*.

Another embodiment of a connector **200**C will now be described with reference to FIG. **8**. Similarly to the connectors **200**A and **200**B, the connector **200**C includes a receptacle **221** that defines an opening **221***a* therethrough. The receptacle **221** is similar to the receptacles **201** and **210** of the connectors **200**A and **200**B, respectively. The connector **200**C may include a pair of substantially parallel sections **222***x*, **224***x* extending from the receptacle **221**. At distal ends of each of the sections **222***x*, **224***x*, sections **222***y*, **224***y* may extend substantially orthogonally from each of the sections **222***x*, **224***x*.

As shown in FIG. **9**, another embodiment of a connector **200**D may include a single length of wire that is bent symmetrically about an axis x-x centrally extending along a length of the connector **200**D. A first point **230** of the wire may be bent toward a second point **231** of the wire to form a substantially closed proximal section that defines a receptacle **232**P having an opening **232**, and an open section that includes a pair of two substantially parallel, distal sections **233**, **234** which may be welded or otherwise secured to the longitudinal wires **112** of the MSE.

The connectors **200**A-**200**D may be configured and/or adjusted to have varying dimensions by bending the wire forming the connector in different ways. As shown in FIGS. **10**A-**10**C, the connector **200**A is bent in such that the distal sections **202***x*, **204***x* of respective first and second legs **202**, **204** are spaced apart by different widths Y**1** (FIG. **10**A), Y**2** (FIG. **10**B), and Y**3** (FIG. **10**C) corresponding to the spacing of the longitudinal wires **112** apart from one another to which the connector is be coupled (e.g., resistive welded).

As shown in FIG. **11**, the connector **200**C provides multiple points for securing (e.g., welding) the connector to the longitudinal wires **112**. The sections **222***x* and **224***x* may be welded along substantially their entire lengths to respective ones of the longitudinal wires **112** and the orthogonally extending sections **224***y*, **224***y* may facilitate stabilizing the connector **200**C relative to the longitudinal wires **112** when welding the connector **200**C to the longitudinal wires **112**.

As shown in FIG. **12**, the connector **200**D may be secured to the longitudinal wires **112** by securing the distal sections **233**, **234** of the legs to respective ones of the longitudinal wires **112**. The distal sections **233**, **234** may also be secured to the transverse wire **114**, and the area in which the first and second points **230**, **231** are drawn together to form a distal end of the opening **232** may be secured to another transverse wire **114** to stabilize the connector **200**D relative to the longitudinal wires **112**.

FIG. **13** illustrates the connector **200**B being coupled to the anchor **108** via fastener such as the bolt of the nut and bolt assembly **130**. Any of the connectors **200**A, **200**C, **200**D may be similarly connected or coupled to the anchor **108**. When one of the connectors **200**A-**200**D is coupled to the anchor **108**, the connector may be hingedly coupled to the anchor **108** such that the combined connection allows the soil reinforcing element to swivel in a horizontal plane.

A method of manufacturing the connectors **200**A, **200**B may include: providing a length of wire, which may be a metal (e.g., stainless steel); and bending the wire into a shape defining a central opening **201***a* at a proximal end and including two substantially parallel longitudinally extending distal sections **202***x*, **204***x* at a distal end thereof. Preferably, the distal sections **202***x*, **204***x* defines a suitable length for welding (e.g., via resistive welding) the distal sections **202***x*, **204***x* to longitudinal wires **112** of the MSE. For example, the tensile strength of the assembly of the connector **200**A and the longitudinal wires **112** should be roughly the same as that of the longitudinal wires **112** such that the weld is not a weakened. Although preferably the coupling of the connector **200**A to the longitudinal wires **112** at the distal end of the connector **200**A is achieved via welding, e.g., resistive welding in which metal is not added, other techniques including metal added welding techniques may alternatively or additionally be utilized. Preferably, distal sections **202***x*, **204***x* which are to be welded to the longitudinal wires **112** have a suitable length for welding them to the longitudinal wires **112** such that the strength of the weld is sufficient to resist tensile and/or shear forces that might be applied.

The wire which forms the connector **200**A may be bent using a mandrel (not shown) and the receptacle **201**, defining the opening **201***a*, at the proximal end may be formed by turning the wire a number a desired number of turns or degrees (e.g., 180 degrees or 540 degrees) such that the proximal end of the connector is coiled and defines a shape having an opening extending lengthwise through the coil. The opening **201***a* may be configured to accept a fastener, e.g., a bolt, when placed in an anchoring system at the wall face. Immediately after the bend the two wires continue and extend substantially horizontal to one another for a slight distance. The bottom horizontal wire is then deflected up while the top horizontal wire is deflected down so they deflect and continue in the same plane. The two wires are then deflected at an angle then are deflected back so they are parallel to the longitudinal wires of the soil reinforcing. The first deflected angel is a function of the distance the longitudinal wires are spaced from one another. The second deflection angle is a function of the angle required to bring them parallel with the longitudinal wires. By allowing the first deflection angle to vary the length of the connection wire can be limited keeping the cost of the connection uniform.

While the present disclosure may have been shown and described with reference to various embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the scope and spirit of the present disclosure as defined by the appended claims and their equivalents. In other words, the various exemplary embodiments disclosed in the present specification and drawings are merely specific embodiments to facilitate an understanding of the various aspects of the present disclosure and are not intended to limit the scope of the present disclosure. For example, the particular ordering of the steps may be modified or changed without departing from the scope and spirit of the present disclosure. Therefore, the scope of the present disclosure is defined not by the detailed description of the disclosure but by the appended claimed, and all differences in the scope should be construed as being included in the present disclosure.

What is claimed is:

1. Soil reinforcing elements for attachment to mechanically stabilized earth structures, comprising:

a plurality of reinforcing gridworks for attachment to anchors of the mechanically stabilized earth structures, each comprising a first wire extending in a longitudinal direction having a proximal end, and a second wire extending in the longitudinal direction having a proximal end spaced apart by a width orthogonal to the longitudinal direction, wherein the first and second wires of different reinforcing gridworks are spaced apart by different widths;

a plurality of connection elements, each comprising a single length of wire forming a first leg attached to the proximal end of the first wire, a fastener receptacle in unitary construction with the first leg, and second leg in unitary construction with the fastener receptacle attached to the proximal end of the second wire;

wherein each fastener receptacle comprises a bend about an axis orthogonal to the longitudinal direction forming a swivel comprising a loop of the single length of wire of at least 365 degrees for connection to the anchor;

wherein the first and second legs of each connector element are bendable to selectively align, abut and weld the connector element to the first and second wires of the different reinforcing gridworks spaced apart by different widths.

2. The soil reinforcing element of claim **1**, wherein the first wire is substantially parallel to the second wire.

3. The soil reinforcing element of claim **1**, further comprising a plurality of transverse wires connecting the first and second wires.

4. The soil reinforcing element of claim **1**, wherein the single length of wire defines a cross-section that is round, square, rectangular, hexagonal, octagonal, or a combination thereof.

5. The soil reinforcing element of claim **1**, wherein the swivel comprises a loop of the single length of wire of at least 540 degrees.

6. The soil reinforcing element of claim **1**, wherein:

the first leg further comprises a first a section extending in the longitudinal direction to a distal end, and a second section extending orthogonally from the distal end; and

the second leg further comprises a first section extending in the longitudinal direction to a distal end, and a second section extending orthogonally from the distal end.

7. A mechanically stabilized earth structure comprising:

a facing comprising a back face located adjacent to an earthen formation or backfill;

a plurality of anchors extending from the back face;

a plurality of soil reinforcing elements, each attached to a respective anchor and comprising:

a reinforcing gridwork extending into the earthen formation or backfill comprising a first wire extending in a longitudinal direction having a proximal end, and a second wire extending in the longitudinal direction having a proximal end spaced apart by a width orthogonal to the longitudinal direction,

a connection element comprising a single length of wire forming a first leg attached to the proximal end of the first wire, a fastener receptacle in unitary construction with the first leg, and second leg in unitary construction with the fastener receptacle attached to the proximal end of the second wire,

wherein the fastener receptacle comprises a bend about an axis orthogonal to the longitudinal direction forming a swivel comprising a loop of the single length of wire of at least 365 degrees connected to the anchor; and

wherein the first and second wires of different reinforcing gridworks are spaced apart by different widths; and

wherein the first and second legs of each connection element are bent to selectively align, abut and weld the connector element to the first and second wires of respective reinforcing gridworks spaced apart by different widths.

8. The mechanically stabilized earth structure of claim **7**, wherein the first wire is substantially parallel to the second wire.

9. The mechanically stabilized earth structure of claim **7**, further comprising a plurality of transverse wires connecting the first and second wires.

10. The mechanically stabilized earth structure of claim **7**, wherein the single length of wire defines a cross-section that is round, square, rectangular, hexagonal, octagonal, or a combination thereof.

11. The mechanically stabilized earth structure of claim **7**, wherein the swivel comprises a loop of the single length of wire of at least 540 degrees.

12. The mechanically stabilized earth structure of claim **7**, wherein:

the first leg further comprises a first a section extending in the longitudinal direction to a distal end, and a second section extending orthogonally from the distal end; and

the second leg further comprises a first section extending in the longitudinal direction to a distal end, and a second section extending orthogonally from the distal end.

13. A method for reinforcing mechanically stabilized earth structures, comprising:

providing a plurality of reinforcing gridworks, each comprising a first wire extending in a longitudinal direction having a proximal end, and a second wire extending in the longitudinal direction having a proximal end, the first and second wires spaced apart from each other by a width orthogonal to the longitudinal direction, wherein the first and second wires of different reinforcing gridworks are spaced apart by different widths;

providing a plurality of connection elements, each comprising a single length of wire forming a first leg, a fastener receptacle in unitary construction with the first leg comprising a loop of the single length of wire of at least 365 degrees, and second leg in unitary construction with the fastener receptacle;

for each of a plurality of selected connection elements:

bending one or both of the first and second legs of a selected coupling element to be spaced apart from each other by a displacement corresponding to the width of a selected gridwork to align and abut the connector element to the first and second wires;

resistive welding the first leg of the selected connection element to the first wire of the selected gridwork;

resistive welding the second leg of the selected connection element to the second wire of the selected gridwork;

coupling the fastener receptacle of the selected connection element to an anchor of a mechanically stabilized earth structure.

14. The method of claim **13**, wherein the step of coupling the fastener receptacle to the anchor comprises bolting.

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